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TWO THREE-METAL CHEMICAL COMPOUNDS ($NaKHg_2$ and NaCdHg)

Ernst Jänecke

Translation of "Über zwei chemische Verbindungen dreier Metalle unter sich ($NaKHg_2$ und NaCdHg)"
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In the study of the two ternary systems Na-K-Hg and Na-Cd-Hg, a great /507* number of melting and solidification temperatures were observed for different mixtures (over 400 mixtures of NaKHg and over 100 in the case of NaCdHg). The investigation has been temporarily halted, but it will be completed at a later date and then published. In addition to the finding of a large number of binary chemical compounds which have previously been known in part, the most important result of the experiments is the discovery in each of the two systems of a chemical compound that simultaneously contains the three metals. These compounds are characterized by a unique melting point and also by the fact that all alloys that are related in composition to these chemical compounds have a melting point that is lower than the melting point of the chemical compound. Under the microscope there is the same homogeneous crystalline structure. The cooling curves according to the table are presented in the figure.

Both curves show pronounced supercooling of the molten compounds below these melting points. The melting temperature is maintained for several minutes (two to four minutes) when about 100 g of the compounds are used, in the case /509 of NaCdHg and $NaKHg_2$. In addition to the cooling curves directly observed, two "reduced" cooling curves have been constructed. These were found by correlating the exactly observed cooling time (about 1 second) for the best time temperature (columns I-II) and the cooling time of a normally cooling material (100 g pure /510 Hg, column III). For higher temperatures, 360 to 330°, the time of cooling of mercury was extrapolated according to the formula $Z=A(B-\log T)$ where Z=time, T=temperature, A and B being constants that are associated with the cooling material (Hg) and with the experimental apparatus. In normally cooling bodies, the formula excellently represents the cooling. The figure distinctly shows the advantage of representation using cooling curves reduced in this manner.

The compound $NaKHg_2$ consists of handsome steely blue shimmering truncated six-sided prisms that become dull in air. It is prepared by carefully bringing together under paraffin stoichiometric proportions of Na, K and Hg, or by melting together mixtures of Na, K and Hg in any manner known. $NaKHg_2$ (melting point 188°) is between the two compounds NaHg (copper red, melting point 217°)

*Numbers given in margin indicate pagination in original foreign text.

Cooling curves

I. Temperature (uncorr.)	II. Time NaCdHg	III. Time Hg	IV. II. - III.
360°	0 Min. 47 sec	-0 Min. 33 sec	1 Min. 20 sec
350	1 0	-0 20	1 20
340	1 13	-0 6	1 19
330	1 26	+0 8	1 18
320	1 41	+0 25	1 17
315	1 48	- -	1 17[1])
310	2 0	+0 42	1 18
306	2 13	- -	1 25[1])
310	2 20	+0 42	1 38
312	2 30	- -	1 52[1])
312.5°	2 Min. 35 sec	- Min. - sec	1 Min. 58[1]) sec
312	2 47	- -	2 9[1])
311	3 1	- -	2 21[1])
310	3 11	- -	2 29[1])
305	3 47	- -	2 57[1])
300	4 7	0 58	3 9
295	4 24	- -	3 17[1])
290	4 38	1 16	3 22
280	5 0	1 33	3 27
270	5 20	1 52	3 28
260	5 40	2 12	3 32
230	6 54	3 17	3 37
220	7 17	3 41	3 36
210	7 41	4 4	3 37
200	8 8	4 31	3 37
190	8 32	4 58	3 34
170	9 30	5 55	3 35
160	10 6	6 30	3 36
150	10 46	7 8	3 38
	$NaKHg_2$		
260°	2 Min. 20 sec	2 Min. 12 sec	0 Min. 8 sec
250	2 42	2 33	0 9
230	3 29	3 17	0 12
225	3 42	- -	0 13[1])
220	3 55	3 41	0 14
215	4 7	- -	0 14[1])
210	4 22	4 4	0 18
205	4 35	- -	0 17[1])
200	4 51	4 31	0 20
195	5 6	- -	0 22[1])
190	5 22	4 58	0 24
185	5 40	- -	0 29[1])
180	5 55	5 25	0 30
175	6 13	- -	0 33[1])

Cooling curves (continued)

I.	II.		III.		IV.	
Temperature (uncorr.)	Time NaCdHg		Time Hg		II. - III.	
170	6	32	5	55	0	37
165.5	7	50	-	-	0	35[1])
184	7	2	-	-	0	48[1])
184	7	10	-	-	0	58[1])
183	7	38	-	-	1	21[1])
182	8	0	-	-	1	40[1])
181	8	20	-	-	1	58[1])
180	8	37	5	25	2	12
179	9	53	-	-	2	25[1])
178	9	4	-	-	2	33[1])
177	9	45	-	-	3	11[1])
176	10	12	-	-	3	35[1])
175	10	23	-	-	3	43[1])
170	10	53	5	55	3	58
165	11	4	-	-	4	19[1])
160	11	18	6	30	4	48
150	11	51	7	8	4	49
140	12	28	7	39	4	49
130	13	6	8	20	4	46
120	13	54	9	0	4	54

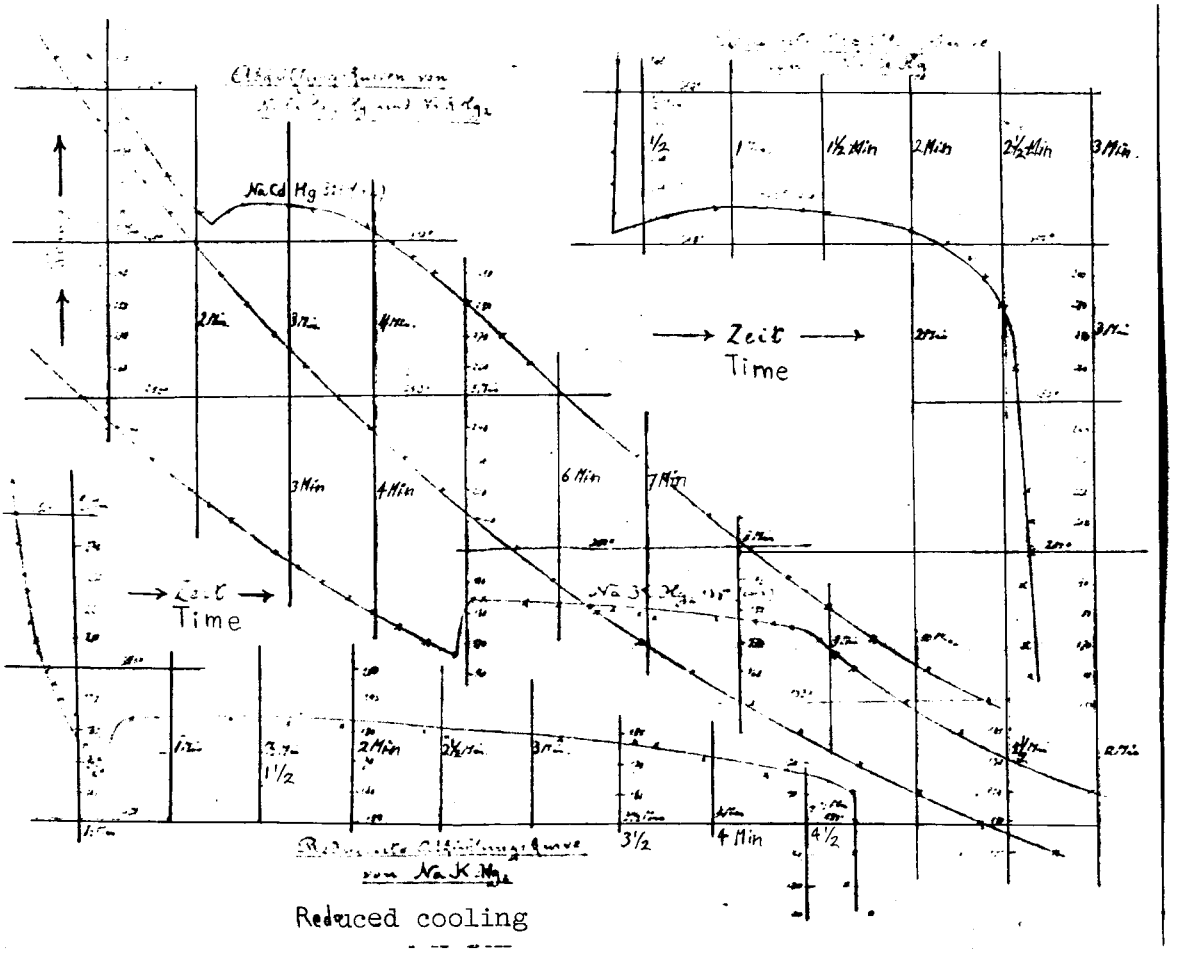
1) Note to table. Column III is graphically interpolated.

and KHg (bronze colored, melting point 178°). With addition of NaHg the melting point is lowered by a corresponding amount of about 15°; with addition of KHg by about 18°, and with addition of Hg by about 5°, increasing again with further additions of NaHg, KHg and Hg. Addition of Na, K or amalgams with higher content of these metals than NaHg, $NaKHg_2$ and KHg of course also acts to lower the melting point.

The compound NaCdHg (melting point 325°) consists of light crystals of the regular system (tetrahedra and displaced octahedra). In its composition it is between the chemical compounds $NaHg_2$ (melting point 350°) and $NaCd_2$ (melting point 380°) and can also be obtained by melting together the same or corresponding amounts of Na, Cd and Hg. The melting point of NaCdHg measured with a thermometer filled with mercury under pressure, with a suitable addition of $NaCd_2$ and NaHg, is lowered by about 20°. If a mixture that has nearly the composition NaCdHg is partially melted (under paraffin) and the liquid fraction poured off, the melting point of the residue rises. With multiple repetition of this operation the NaCdHg compound which has the highest melting point finally results. Except for these two chemical compounds, no others are as yet known that simultaneously contain three metals.

Cooling curves of
NaCd Hg, Hg and $NaKHg_2$

Reduced cooling curve
of NaCdHg



Reduced cooling
curve of $NaCdHg_2$

Translated for the National Aeronautics and Space Administration
by John F. Holman and Co. Inc.

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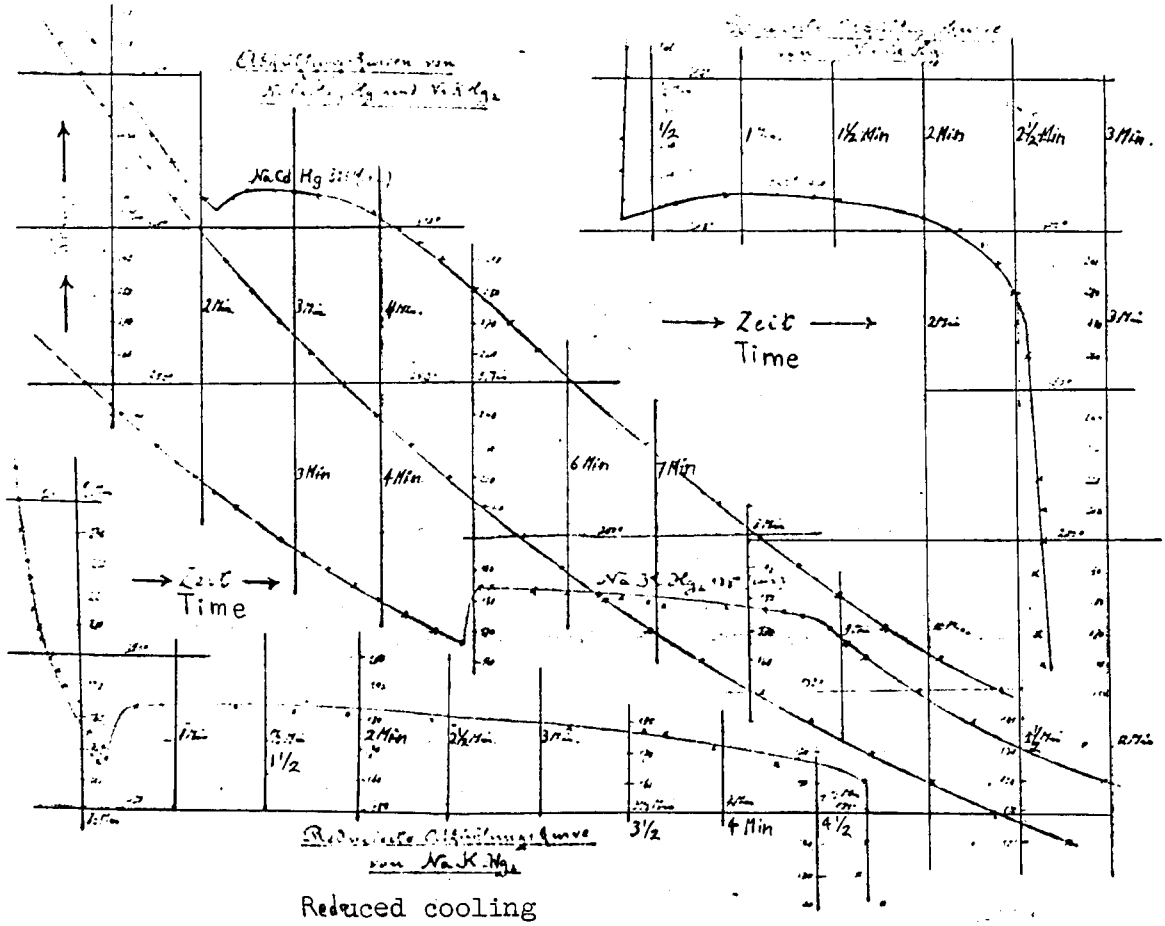

Reduced cooling
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